The Enlightenment

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1 Isaac Newton

Into the Light **Imagine yourself in a dark room. You can't see anything—not even your hand before your face. Then someone lights a candle. At firs you see only shapes and shadows. Then a second candle is lit, followec by a third candle, and a fourth.**

As the glow of light brightens the room, the darkness gradually turns into light. How grateful you are for the candles that brought this "enlightenment."

Nowadays when the term *Enlightenment* is used, it does not refer to lighting candles, but to a period in history in Europe in the 1600s and 1700s. Then, there were people all over Europe who believed that the darkness of the past was giving way to light. The darkness was ignorance, superstition, and unproven beliefs; the light was knowledge.

What "candle" brought this new light? It was reason, people's unique ability to question, analyze, and reach conclusions based on their own experience, not on what the Bible or some other authority said. John Locke, an English thinker of this period, (you will read about him later) described reason as "the candle in men's minds . . . [that] must be our last judge and guide in everything."

You read about moving from darkness into light in the unit on the Renaissance.

Isaac Newton was one of the first to light the candles of the Enlightenment.

The Renaissance paved the way for the Enlightenment. But while Renaissance thinkers turned to ancient Greece and Rome for inspiration, educated Europeans of the 1600s and 1700 turned to reason. They said we no longer had to guess about the universe or accept the beliefs of ancient authorities. They said that human beings, with reason and experience as their guides, could uncover the laws of nature and even come to understand the basic principles of human society and government.

The Enlightenment, also called the Age of Reason, changed history and created the beginning of the modern world we live in today. It brought revolutions ir science, mathematics, and government.

Setting the Scene

Let's look at Western Europe in the early seventeenth century, on the eve of the Enlightenment. For a small group of upper-class people, home was a palace or manor. Within the grand houses, every object—each candlestick, each knife and fork and spoon—was

a work of art. The lords and ladies of this upper class dressed in lace and silk. They wore white wigs and danced the **minuet** (mihn YOO et). Kings ruled by "divine right"—the belief that a monarch's right to the throne was granted by God. In this world, everyone owed obedience to the king. The king did as he pleased.

vocabulary
minuet a slow, graceful dance that involves much bowing and toe-pointing

Life was very different for the lower classes: the peasants, the workers, and the soldiers. For these people, life was hard. Many city dwellers lived in crowded slums. Peasants worked from dawn to dusk but owned nothing. Fewer than half the babies born ever reached adulthood. Very few people lived to old age. Prisons were full, and torture was legal. People had no rights or freedom. For most people of the lower class, life was filled with suffering and hard work.

But a new class of people was rising, neither as rich as the nobles nor as poor as the peasants. Those who belonged to this middle class were destined to be the leaders of the Enlightenment. As towns and cities grew during this time, merchants, bankers, traders, and skilled craftsworkers thrived.

Some grew rich and lived much like the lords and ladies who surrounded the monarchs. The members of this new middle class were called burgers, because they mostly lived in burgs, or towns. Today we still call the middle class the bourgeoisie (boor jwah ZEE) from the French word *bourgeois*, (boor JWAH) meaning "town dweller."

Isaac Newton

Into this setting came a man who was one of the greatest scientists in history and who changed the world forever: Isaac Newton. Born in England on Christmas Day, 1642, young Isaac was a tiny baby, described as so small he could "fit into a quart pot." But this tiny baby would become an intellectual giant. Isaac Newton would discover the laws of gravitation and motion, invent a new branch of mathematics called calculus, and reveal the secrets of light and color—all in an eighteen-month period.

Newton also experimented with light and mirrors.

How did he do it? Like any person today, Newton relied on his ability to observe things and to think about what he observed. But unlike most people, Newton was one of the great geniuses of history. In later life he wrote, "I seem to have been only like a boy playing on the seashore . . . now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me." The idea that truth is like a great ocean waiting to be discovered was one of the central ideas of the Enlightenment.

Newton never stopped being fascinated by nature. He spent long childhood hours observing it. His father had died before he was born, and

his mother was absent for long periods. By all accounts, Newton was a lonely boy, who passed the time inventing mechanical devices and reading. Young Isaac built a tiny windmill that could actually grind corn into cornmeal. He made a clock that used the force of falling water for power.

Isaac had a reputation for being somewhat absent-minded—particularly when he settled down with a good book. This reputation was made one day when he got absorbed in his reading and let the sheep he was supposed to be watching run off. (He was fined four shillings four pence for his runaway livestock, a considerable sum of money in those days.) Nobody considered young Isaac a genius when he went off to the university, but the world hasn't been the same since.

What Goes Up, Must Come Down!

At 19, Newton entered Cambridge, one of England's finest universities, where he studied mathematics. Newton's interests took him outside the college walls, too. He read books before his professors assigned them and learned about chemistry (which wasn't taught at universities in those days) from a local pharmacist.

While Newton was at Cambridge, a deadly disease spread through England. The **plague** (playg) of 1665 shut down many public places, including the university. People fled from cities, hoping to escape the disease. Newton returned to his childhood home in the country. There he waited out the epidemic with little to do but think. Those two years at home were the most productive of his life.

There is a well-known story about how Newton made his most famous discovery in one of his solitary moments. Here's how it goes: Young Isaac Newton was sitting in his garden when Plop! an apple fell from a tree and knocked him on the head. What would most people have done about that apple? They might have ignored it or, perhaps, eaten it. But Isaac began to ask what caused the apple to fall down. His questions led him to discover the theory that a force pulls objects to the earth, a force called **gravity.**

Newton wondered, "Could the same laws of gravity that attract objects to Earth apply to other parts of the universe? Why does the moon stay in its orbit? What keeps it from flying off into space?"

Scholars before Newton had already made important discoveries about our solar system. Do you remember Copernicus and Galileo? In the mid-1500s, Copernicus concluded that the earth moves around the Sun. In the early 1600s, Galileo used his telescope to find the evidence that proved Copernicus was right. (But, as you may recall, they both had plenty of trouble getting the Church to

vocabulary

plague a disease that is deadly and spreads rapidly

gravity the force that pulls objects in the earth's atmosphere toward the earth

No one knows if the apple story is true or not, but Newton did formulate the theory of the law of gravity.

accept the fact that Earth orbits the Sun.) It was left to Newton to explain what held the heavenly bodies in place in the sky.

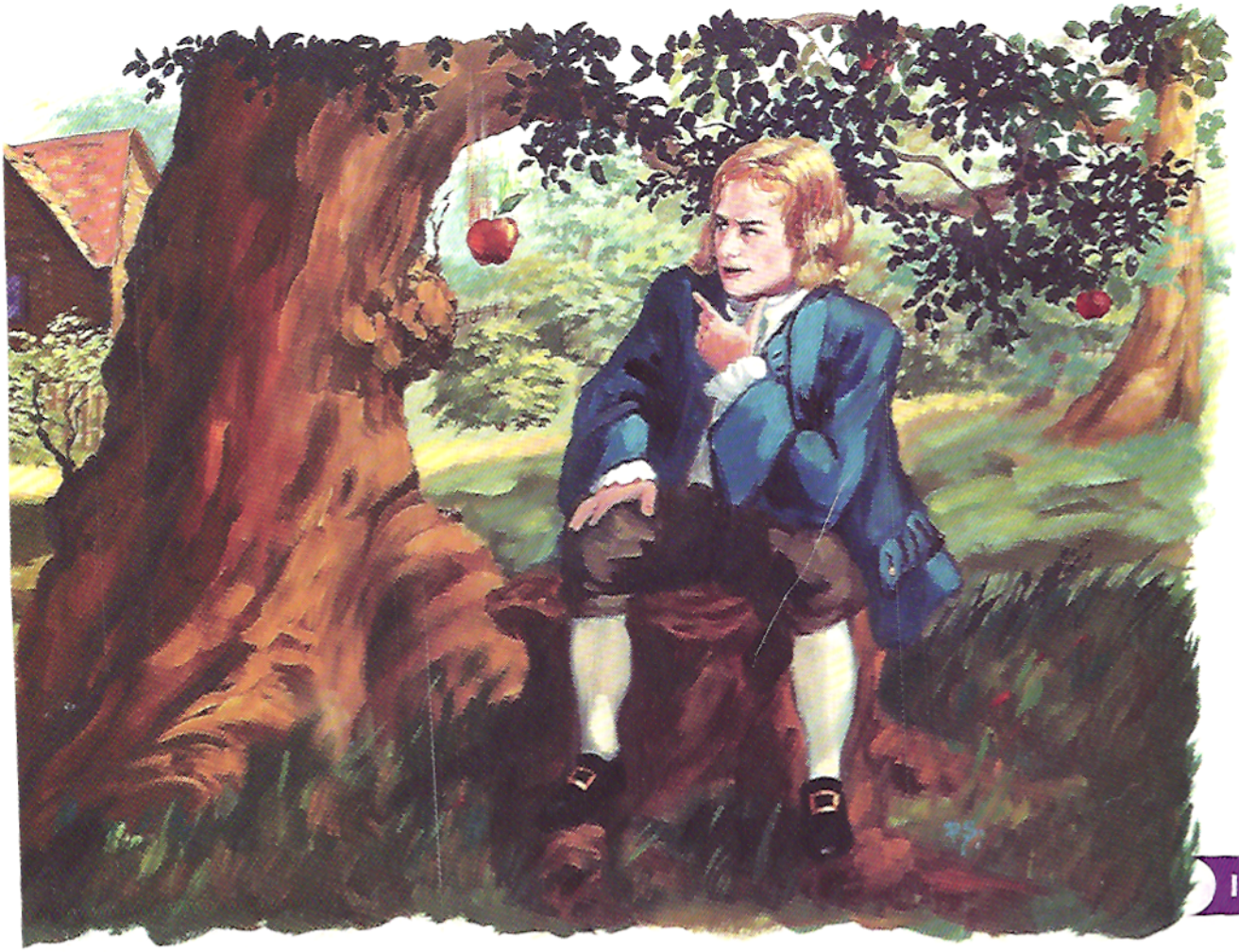
Newton thought of the falling apple. He reasoned that the laws of science that apply on Earth must also apply everywhere else—in other words, he said, these are universal laws of science. The same force of gravity that attracted the apple, he said, keeps the moon in orbit around Earth. It also keeps the planets in orbit around the Sun. (But, you might ask, if gravity makes the apple fall to the ground, then why doesn't it make the moon fall to Earth? That's because the moon is moving very fast as it orbits Earth. The speed of the moon, which pushes it outward away from Earth, is exactly balanced by the force of gravity that pulls it toward Earth.)

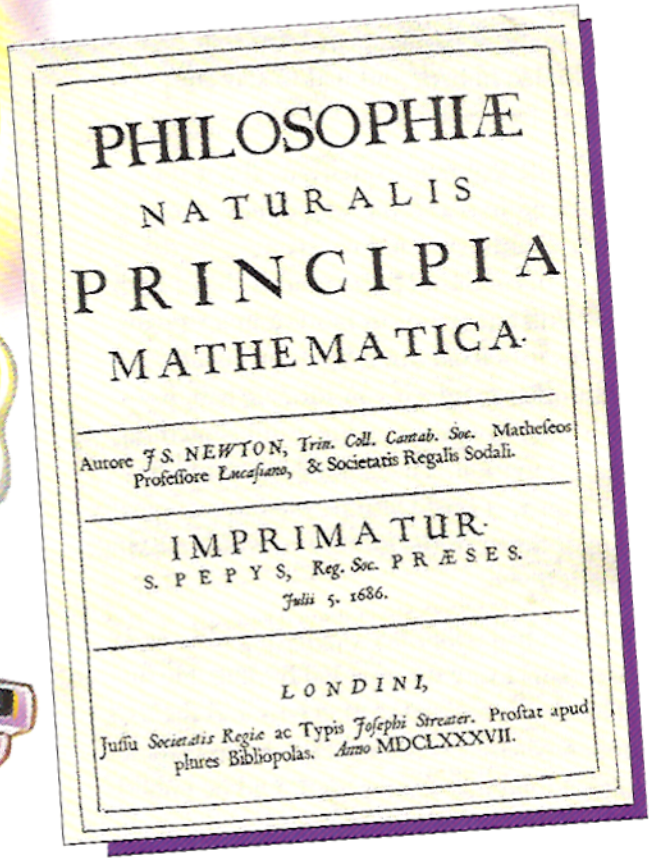
Questions About the Natural World

As a young man, Newton thought of little but the natural world. His passion for experimenting led him to try some foolish experiments. Once, he stared at the sun with one eye until he could no longer bear it. He wanted to see what would happen. What happened was that Newton nearly blinded himself and had to stay shut up in the dark for several days.

Newton asked many questions about the world around him and the way things work. Through experiments and observation he developed laws of motion. He concluded that a body remains either at rest or in motion in a straight line unless it is acted upon by some outside force. In other words, if you throw a ball, it will continue to move in a line until something changes its motion. That something could be a catcher's mitt. It could also be the force of gravity drawing it down to the ground or wind resistance slowing it down.

Newton had a number of amazing ideas and discoveries in a very short period of time. He finished his first investigation of gravity and the laws of motion when he was only 24. He also invented calculus during that same period. Did he publish his discoveries and immediately change the scientific and mathematical worlds? No, not yet. He was





PHILOSOPHIÆ
NATURALIS
PRINCIPIA
MATHEMATICA.

Autore J S. NEWTON, Trin. Coll. Cantab. Soc. Matheseos Professore Lucasiano, & Societatis Regalis Sodali.

IMPRIMATUR.
S. PEPYS, Reg. Soc. PRÆSES.
Julii 5. 1686.

LONDINI,
Jussu Societatis Regiæ ac Typis Josephi Streater. Prostat apud plures Bibliopolas. Anno MDCLXXXVII.

Because the Principia *was written in Latin, scholars all over Europe could read it easily and be influenced by Newton's work.*

young and uneasy about publishing them. Even after Newton graduated from Cambridge and became a professor there, he put forth his views with caution. Some people accused him of keeping secrets and not wanting to share his findings. Actually, he was a modest man who disliked quarreling. He held back because he dreaded criticism. It took great courage for Newton to publish each new idea.

Knowledge Through Reason

After two and a half years of solitary study, Newton produced a major body of writing. His *Principia Mathematica,* or *Mathematical Principles,* explained the law of gravity and laws of motion in mathematical terms. Newton did not publish it at the time—perhaps because he understood the "gravity" of his discoveries. He had just begun to teach at the university. He knew his findings were revolutionary and probably would upset people.

Twenty years passed. Finally, some English scholars approached Newton with a question that he could answer because of his early work. Newton lent these scientists his *Principia,* and they were amazed. They urged Newton to publish this important work, and one of them even offered to pay for the printing.

The publication of the *Principia* is one of the great events in the history of science and thought. Here was the first work to set forth mathematical principles for the operation of the natural world. Newton insisted that certain basic laws of nature held true throughout the whole physical world. These principles, he explained, could be discovered through the use of observation and reason.

Isaac Newton inspired confidence in science and reason. He showed that, through inquiry, observation, calculation, and experimentation, it was possible to understand many of nature's laws. People read his work and became more optimistic about human prospects and progress.

Thanks to Newton, more and more people gained confidence in human reason and observation as a way of understanding and explaining the world. Thinkers now asked: "If we can use reason to understand the laws of the physical world, can we use reason to understand 'laws' in other areas too? Can reason help us understand human behavior?" They began to examine politics, religion, and society. They began to observe the world around them and to ask questions.

It was Newton who had opened the door to a new understanding of the world, and the people of his era knew it. This modest man, this intellectual giant, became the first scientist ever knighted by an English queen. Sir Isaac Newton lit a very bright candle in the Age of Reason.